DRAFT APPENDIX F

Assessing Vulnerability: Private Building and Value Exposure Estimates

This appendix discusses the number of buildings and dollars exposed to the hazards listed in the Local Hazard Mitigation Plan. For this appendix, ABAG created estimates of the number of buildings and the real value of property based upon County Tax Assessor's information. Since no other attempt to value the real property in the Bay Area has used this method, a thorough methodology is included in this appendix.

The numbers in this appendix are an estimate of the 2005 market value of private improvements. ABAG created these values only to provide estimates of property at risk in hazard areas. They do not represent scenarios of loss due to hazards, nor do they represent the replacement value (cost of repairing or replacing a structure) that would be damaged or destroyed during a hazard event. In addition, they do not include public and other nontaxable improvements, as assessors do not assess the value of these properties.

Almost all of the assumptions made in this analysis tend to underestimate the number and value of buildings in the Bay Area. It is likely that the number of private buildings and actual market value of private improvements in the region is much higher.

The final section of this appendix discusses the uses and limitations of these estimates when creating loss estimates for specific hazards based upon the probability of various hazards resulting in damage, as well as the percent loss expected to occur to selected building types in various categories of hazard.

Exposed Value of Private Buildings

According to these ABAG estimates, the total market value of private improvements in the Bay Area is $1.064 trillion, 78.7% ($837.4 billion) of which is residential property, 13.4% ($142.3 billion) of which is commercial, and 7.9% ($84.2 billion) of which is industrial/other. This estimate includes only taxable properties that the assessor has assessed a value for, and does not include properties that are public or exempt from taxation. ***Table 1*** shows the value of these properties in each high hazard area (see LHMP appendix E for the definition of the high hazard areas for each hazard) for each county and across the region. The majority of value in the region is in Santa Clara, Alameda, and Contra Costa counties, which contain 57.0% of the region's improvement value.

Examining the exposure by type of development (in ***Table 2***) reveals that residential properties make up the bulk of the exposed value in the region for every hazard. One can determine if properties are disproportionately exposed to hazards by comparing the percentage of value in each high hazard area to the overall percentage of value in the region. For example, if the percentage of exposed residential value for a particular hazard is higher than 78.7%, the residential properties are disproportionately exposed to that hazard. In this manner, one can see that residential properties are disproportionately exposed to fault rupture, landslides (both rainfall and earthquake-induced), and fire threat (both wildfire and wildland urban interface [WUI]). Commercial properties are disproportionately exposed to shaking, liquefaction, and flooding. All other properties are disproportionately exposed to fault rupture, liquefaction, rainfall induced landslides, wildfire threat, dam failure, and especially flooding.

TABLE 1 - Estimated Value of Properties in High Hazard Areas* by County (millions of dollars)

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone	100-Year FEMA Flood Zone	Rainfall-Induced Landslides	Wildfire Threat Area	WUI Threat Area	Dam Failure Inundation Area
9-County Region											
Total Value	1,064,043	19,507	729,932	511,103	194,960	14,533	57,843	34,597	66,739	553,285	212,623
Residential	837,459	16,313	564,532	375,289	132,222	13,471	32,962	30,038	54,312	467,591	149,620
Commercial	142,293	1,059	111,216	94,403	41,842	596	13,458	1,652	3,712	54,358	37,415
Industrial	84,291	2,135	54,184	41,411	20,896	466	11,423	2,907	8,715	31,336	25,588
Alameda County											
Total Value	187,772	6,494	165,780	96,455	71,614	8,481	5,278	5,090	8,450	98,011	63,163
Residential	153,329	5,815	134,689	74,754	53706	8,005	3,878	4,639	7,344	84,780	49,140
Commercial	19,889	543	18,246	12,430	7749	355	1,045	232	586	8,356	7,298
Industrial	14,554	136	12,845	9,271	10,159	121	355	219	520	4,875	6,725
Contra Costa County											
Total Value	171,869	4,690	89,612	60,049	N/A	N/A	11,289	11,111	17,848	117,713	26,033
Residential	124,098	2,801	60,873	41,465	N/A	N/A	4,256	10,188	15,652	91,713	12,567
Commercial	20,919	249	13,575	9,998	N/A	N/A	1,964	479	582	11,375	3,707
Industrial	26,852	1,640	15,164	8,586	N/A	N/A	5,069	444	1,614	14,625	9,759
Marin County											
Total Value	48,038	209	17,719	18,985	N/A	N/A	5,486	6,705	7,011	39,033	2,562
Residential	39,450	158	13,488	13,764	N/A	N/A	3,201	5,788	5,737	33,640	1,928
Commercial	6,046	28	3,176	4,081	N/A	N/A	1,619	471	637	4,057	493
Industrial	2,542	23	1,055	1,140	N/A	N/A	666	446	637	1,336	141
Napa County											
Total Value	21,381	137	53	5,037	N/A	N/A	1,641	605	3,990	11,667	4,342
Residential	14,502	104	16	3,179	N/A	N/A	850	254	1,814	9,630	2,797
Commercial	1,840	10	0	596	N/A	N/A	308	6	313	913	538
Industrial	5,039	23	37	1,262	N/A	N/A	483	345	1,863	1,124	1,007
San Francisco County											
Total Value	98,194	0	79,722	57,351	23,210	1,343	0	295	157	34,987	4,464
Residential	71,802	0	56,502	34,559	9,324	1,269	0	287	157	32,760	4,310
Commercial	23,584	0	20,679	20,383	13,049	73	0	8	0	1,988	137
Industrial	2,808	0	2,541	2,409	837	1	0	0	0	239	17
San Mateo County											
Total Value	145,937	3,411	135,295	57,736	N/A	N/A	6,661	3,587	4,657	85,981	24,019
Residential	116,238	3,155	108,481	42,532	N/A	N/A	4,263	3,167	3,316	71,406	18,177
Commercial	22,238	82	20,813	11,689	N/A	N/A	1,379	104	407	11,576	4,794
Industrial	7,461	174	6,001	3,515	N/A	N/A	1,019	316	934	2,999	1,048
Santa Clara County											
Total Value	247,135	1,576	184,952	163,299	100,136	4,709	23,153	2,512	6,514	95,910	83,659
Residential	193,968	1,471	141,325	122,293	69,192	4,197	13,478	1,885	4,911	80,370	57,143
Commercial	36,891	42	30,237	29,111	21,044	168	6,632	114	292	12,099	20,007
Industrial	16,276	63	13,390	11,895	9,900	344	3,043	513	1,311	3,441	6,509
Solano County											
Total Value	54,164	304	2,388	18,703	N/A	N/A	2,519	603	1,200	16,928	4,379
Residential	47,601	265	1,746	15,379	N/A	N/A	1,898	561	963	15,346	3,557
Commercial	3,716	8	342	2,029	N/A	N/A	285	21	147	956	440
Industrial	2,847	31	300	1,295	N/A	N/A	336	21	90	626	382
Sonoma County											
Total Value	89,552	2,688	54,400	33,489	N/A	N/A	1,817	4,087	16,909	53,055	0
Residential	76,472	2,545	47,405	27,363	N/A	N/A	1,139	3,269	14,415	47,946	0
Commercial	7,170	98	4,146	4,086	N/A	N/A	227	216	749	3,038	0
Industrial	5,910	45	2,849	2,040	N/A	N/A	451	602	1,745	2,071	0

*See Local Hazard Mitigation Plan Appendix E, Information Sources and Definitions for definitions of high hazard areas and data limitations.
Source: ABAG 2006.

TABLE 2 – Percentage of Estimated Value of Properties in High Hazard Areas* by Type

This table should be read as "Across the region, this percentage of the value in this high hazard area is this type of development."

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone
Total Value	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Residential	78.7%	83.6%	77.3%	73.4%	67.8%	92.7%
Commercial	13.4%	5.4%	15.2%	18.5%	21.5%	4.1%
Industrial/Other	7.9%	10.9%	7.4%	8.1%	10.7%	3.2%
	All Land	**100-Year FEMA Flood Zone**	**Rainfall-Induced Landslides**	**Wildfire Threat Area**	**WUI Threat Area**	**Dam Failure Inundation Area**
Total Value	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Residential	78.7%	57.0%	86.8%	81.4%	84.5%	70.4%
Commercial	13.4%	19.7%	8.4%	13.1%	5.7%	12.0%
Industrial/Other	7.9%	34.7%	9.7%	16.0%	6.7%	17.1%

*See Local Hazard Mitigation Plan Appendix E, Information Sources and Definitions for definitions of high hazard areas and data limitations.
Source: ABAG 2006.

Table 3 shows the percentage of value in each county that is exposed to the high hazard areas. By comparing hazards across the region (or by county), one can begin to understand the potential economic impacts of a hazard event. In this manner, it is clear that the highest exposure of vale to a hazard is in the high hazard areas for shaking potential, WUI threat, and liquefaction. 68.6% ($729.9 billion) of the value in the region is in the high hazard area for shaking, while 52.0% ($553.3 billion) is in a WUI threat area, and 48.4% ($511.1 billion) is in a high liquefaction susceptibility area. One would expect these three high hazard areas to contain the most value in the region, given that these same three high hazard areas contain the highest acreages of urban land in the region (see LHMP Appendix E, figure 2). Of the other hazards, only dam inundation areas contain a significant portion of the value in the region (20.0%).

Table 3 also demonstrates some particular points of note. First, when compared to residential properties, nonresidential (especially commercial) properties generally have a higher percentage of value in high liquefaction susceptibility areas, both across the region and within most counties. This is consistent with the fact that much of the large industrial other non-residential areas are on bay fill right on the Bay shore. For that same reason, non-residential properties have a higher percentage of the value in the 100-year flood zones than do residential properties (although this varies by county). Also, nonresidential properties also have a much higher percentage of value exposed to dam inundation hazards than residential properties. Finally, residential properties have a much higher percentage of value exposed to fire hazards (wildfire and WUI threat) than do nonresidential properties for nearly every county and across the region.

TABLE 3 - Percentage of Estimated Value in Each High Hazard Area* by County (millions of dollars)

This table should be read as "In this county, this percentage of all value of this type is in this high hazard area"

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone	100-Year FEMA Flood Zone	Rainfall-Induced Landslides	Wildfire Threat Area	WUI Threat Area	Dam Failure Inundation Area
9-County Region											
Total Value	100.0%	1.8%	68.6%	48.0%	18.3%	1.4%	5.4%	3.3%	6.3%	52.0%	20.0%
Residential	100.0%	1.9%	67.4%	44.8%	15.8%	1.6%	3.9%	3.6%	6.5%	55.8%	17.9%
Commercial	100.0%	0.7%	78.2%	66.3%	29.4%	0.4%	9.5%	1.2%	2.6%	38.2%	26.3%
Industrial	100.0%	2.5%	64.3%	49.1%	24.8%	0.6%	13.6%	3.4%	2.6%	37.2%	30.4%
Alameda County											
Total Value	100.0%	3.5%	88.3%	51.4%	38.1%	4.5%	2.8%	2.7%	4.5%	52.2%	33.6%
Residential	100.0%	3.8%	87.8%	48.8%	35.0%	5.2%	2.5%	3.0%	4.8%	55.3%	32.0%
Commercial	100.0%	2.7%	91.7%	62.5%	39.0%	1.8%	5.3%	1.2%	2.9%	42.0%	36.7%
Industrial	100.0%	0.9%	88.3%	63.7%	69.8%	0.8%	2.4%	1.5%	2.9%	33.5%	46.2%
Contra Costa County											
Total Value	100.0%	2.7%	52.1%	34.9%	N/A	N/A	6.6%	6.5%	10.4%	68.5%	15.1%
Residential	100.0%	2.3%	49.1%	33.4%	N/A	N/A	3.4%	8.2%	12.6%	73.9%	10.1%
Commercial	100.0%	1.2%	64.9%	47.8%	N/A	N/A	9.4%	2.3%	2.8%	54.4%	17.7%
Industrial	100.0%	6.1%	56.5%	32.0%	N/A	N/A	18.9%	1.7%	2.8%	54.5%	36.3%
Marin County											
Total Value	100.0%	0.4%	36.9%	39.5%	N/A	N/A	11.4%	14.0%	14.6%	81.3%	5.3%
Residential	100.0%	0.4%	34.2%	34.9%	N/A	N/A	8.1%	14.7%	14.5%	85.3%	4.9%
Commercial	100.0%	0.5%	52.5%	67.5%	N/A	N/A	26.8%	7.8%	10.5%	67.1%	8.2%
Industrial	100.0%	0.9%	41.5%	44.8%	N/A	N/A	26.2%	17.5%	10.5%	52.6%	5.5%
Napa County											
Total Value	100.0%	0.6%	0.2%	23.6%	N/A	N/A	7.7%	2.8%	18.7%	54.6%	20.3%
Residential	100.0%	0.7%	0.1%	21.9%	N/A	N/A	5.9%	1.8%	12.5%	66.4%	19.3%
Commercial	100.0%	0.5%	0.0%	32.4%	N/A	N/A	16.7%	0.3%	17.0%	49.6%	29.2%
Industrial	100.0%	0.5%	0.7%	25.0%	N/A	N/A	9.6%	6.8%	17.0%	22.3%	20.0%
San Francisco County											
Total Value	100.0%	0.0%	81.2%	58.4%	23.6%	1.4%	0.0%	0.3%	0.2%	35.6%	4.5%
Residential	100.0%	0.0%	78.7%	48.1%	13.0%	1.8%	0.0%	0.4%	0.2%	45.6%	6.0%
Commercial	100.0%	0.0%	87.7%	86.4%	55.3%	0.3%	0.0%	0.0%	0.0%	8.4%	0.6%
Industrial	100.0%	0.0%	90.5%	85.8%	29.8%	0.0%	0.0%	0.0%	0.0%	8.5%	0.6%
San Mateo County											
Total Value	100.0%	2.3%	92.7%	39.6%	N/A	N/A	4.6%	2.5%	3.2%	58.9%	16.5%
Residential	100.0%	2.7%	93.3%	36.6%	N/A	N/A	3.7%	2.7%	2.9%	61.4%	15.6%
Commercial	100.0%	0.4%	93.6%	52.6%	N/A	N/A	6.2%	0.5%	1.8%	52.1%	21.6%
Industrial	100.0%	2.3%	80.4%	47.1%	N/A	N/A	13.7%	4.2%	1.8%	40.2%	14.0%
Santa Clara County											
Total Value	100.0%	0.6%	74.8%	66.1%	40.5%	1.9%	9.4%	1.0%	2.6%	38.8%	33.9%
Residential	100.0%	0.8%	72.9%	63.0%	35.7%	2.2%	6.9%	1.0%	2.5%	41.4%	29.5%
Commercial	100.0%	0.1%	82.0%	78.9%	57.0%	0.5%	18.0%	0.3%	0.8%	32.8%	54.2%
Industrial	100.0%	0.4%	82.3%	73.1%	60.8%	2.1%	18.7%	3.2%	0.8%	21.1%	40.0%
Solano County											
Total Value	100.0%	0.6%	4.4%	34.5%	N/A	N/A	4.7%	1.1%	2.2%	31.3%	8.1%
Residential	100.0%	0.6%	3.7%	32.3%	N/A	N/A	4.0%	1.2%	2.0%	32.2%	7.5%
Commercial	100.0%	0.2%	9.2%	54.6%	N/A	N/A	7.7%	0.6%	4.0%	25.7%	11.8%
Industrial	100.0%	1.1%	10.5%	45.5%	N/A	N/A	11.8%	0.7%	4.0%	22.0%	13.4%
Sonoma County											
Total Value	100.0%	3.0%	60.7%	37.4%	N/A	N/A	2.0%	4.6%	18.9%	59.2%	0.0%
Residential	100.0%	3.3%	62.0%	35.8%	N/A	N/A	1.5%	4.3%	18.9%	62.7%	0.0%
Commercial	100.0%	1.4%	57.8%	57.0%	N/A	N/A	3.2%	3.0%	10.4%	42.4%	0.0%
Industrial	100.0%	0.8%	48.2%	34.5%	N/A	N/A	7.6%	10.2%	10.4%	35.0%	0.0%

*See Local Hazard Mitigation Plan Appendix E, Information Sources and Definitions for definitions of high hazard areas and data limitations.

Source: ABAG 2006.

TABLE 4 - Estimated Number of Buildings in High Hazard Areas* by County

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone	100-Year FEMA Flood Zone	Rainfall-Induced Landslides	Wildfire Threat Area	WUI Threat Area	Dam Failure Inundation Area
9-County Region											
Total Buildings	1,785,285	29,511	1,185,537	856,893	317,350	23,779	77,990	52,392	81,242	906,355	342,824
Residential	1,663,498	28,026	1,102,831	786,811	289,614	22,828	66,049	48,490	71276	860,260	315,474
Commercial	68,098	795	49,694	41,746	15,010	214	5,381	581	1142	26,166	15,195
Industrial	53,689	690	33,012	28,333	12,726	737	6,560	3,321	8824	19,929	12,155
Alameda County											
Total Buildings	368,120	11,871	332,460	199,343	156,370	15,553	9,265	6,343	11,125	169,524	121,412
Residential	342,263	11,128	308,403	183,086	142860	15,162	8,764	5,984	10,264	160,108	113,759
Commercial	14,128	427	13,521	8,981	6638	145	265	34	101	5,136	3,872
Industrial	11,729	316	10,536	7,276	6872	246	236	325	760	4,280	3,781
Contra Costa County											
Total Buildings	296,809	6,765	146,077	102,828	N/A	N/A	10,412	17,123	21,151	208,248	36,923
Residential	284,272	6,528	139,136	96,182	N/A	N/A	8,950	16,579	19,944	202,041	33,737
Commercial	8373	167	5,299	4,307	N/A	N/A	816	162	227	4,728	2,077
Industrial	4,164	70	1,642	2,339	N/A	N/A	646	382	980	1,479	1,109
Marin County											
Total Buildings	84,209	443	32,305	35,184	N/A	N/A	10,073	10,341	11,246	70,305	5,270
Residential	74,617	371	27,635	29,410	N/A	N/A	7,158	9,800	10,402	63,559	4,479
Commercial	3,761	33	2,183	2,644	N/A	N/A	957	114	236	2,960	467
Industrial	5,831	39	2,487	3,130	N/A	N/A	1,958	427	608	3,786	324
Napa County											
Total Buildings	40,626	370	170	9,015	N/A	N/A	2,989	1,046	5,730	24,633	8,398
Residential	33,999	327	43	7,169	N/A	N/A	2,001	547	3,469	22,137	6,817
Commercial	1,710	19	4	715	N/A	N/A	313	12	62	995	692
Industrial	4,917	24	123	1,131	N/A	N/A	675	487	2,199	1,501	889
San Francisco County											
Total Buildings	148,131	0	119,814	65,678	11,777	1,896	0	514	184	69,583	14,523
Residential	138,383	0	111,654	58,985	8,555	1,874	0	503	184	67,576	14,286
Commercial	7,229	0	5,973	4,646	1,945	21	0	10	0	1,685	207
Industrial	2,519	0	2,187	2,047	1,277	1	0	1	0	322	30
San Mateo County											
Total Buildings	203,106	4,302	187,488	75,529	N/A	N/A	8,973	5,516	3,995	114,610	30,651
Residential	189,046	4,225	174,534	68,429	N/A	N/A	7,608	5,216	3,613	108,979	27,833
Commercial	7,393	45	7,069	3,282	N/A	N/A	625	61	50	3,295	1,077
Industrial	6,667	32	5,885	3,818	N/A	N/A	740	239	332	2,336	1,741
Santa Clara County											
Total Buildings	389,794	3,093	284,302	262,887	149,203	6,330	26,363	3,323	7,364	133,174	115,484
Residential	365,456	2,926	264,760	245,585	138,199	5,792	23,140	2,672	5,683	126,552	105,514
Commercial	15,368	16	12,215	11,477	6,427	48	1,558	48	87	3,781	5,939
Industrial	8,970	151	7,327	5,825	4,577	490	1,665	603	1,594	2,841	4,031
Solano County											
Total Buildings	106,685	488	4,052	39,706	N/A	N/A	5,878	1,074	1,610	38,536	10,163
Residential	99,171	475	3,438	36,121	N/A	N/A	4,951	998	1,464	36,122	9,049
Commercial	4,701	3	336	2,649	N/A	N/A	556	57	66	1,242	864
Industrial	2,813	10	278	936	N/A	N/A	371	19	80	1,172	250
Sonoma County											
Total Buildings	147,805	2,179	78,869	66,723	N/A	N/A	4,037	7,112	18,837	77,742	0
Residential	136,291	2,046	73,228	61,844	N/A	N/A	3,477	6,191	16,253	73,186	0
Commercial	5,435	85	3,094	3,048	N/A	N/A	291	83	313	2,344	0
Industrial	6,079	48	2,547	1,831	N/A	N/A	269	838	2,271	2,212	0

*See Local Hazard Mitigation Plan Appendix E, Information Sources and Definitions for definitions of high hazard areas and data limitations.
Source: ABAG 2006.

Exposed Number of Private Buildings

According to the estimates (based on one building per assessors parcel), the total number of private buildings in the Bay Area is 1.78 million, 93.2% (1.66 million buildings) of which are residential buildings, 3.8% (68,098 buildings) of which are commercial buildings, and 3.0% (53,689 buildings) of which are industrial/other buildings. ***Table 4*** shows the number of buildings in each high hazard area (see LHMP appendix E for definition of high hazard area) for each county and across the region. As with the value, the majority of buildings in the region are in Santa Clara, Alameda, and Contra Costa counties, which contain 59.1% of the region's buildings.

Examining the exposure by type of development (in ***Table 5***) reveals that residential properties make up the bulk of the exposed buildings in the region for every hazard, and make up over 90% of all exposed buildings for every hazard except flooding and wildfire hazards. By making the same comparison in ***Table 5*** that was made for ***Table 2,*** one can again compare the percentage of buildings in each high hazard area to the overall percentage of buildings in the region to determine if a type of building is disproportionately exposed to a hazard. In this manner, one can see that residential buildings are disproportionately exposed to fault rupture, and WUI threat. Commercial properties are disproportionately exposed to shaking, liquefaction (both liquefaction hazards), flooding, and dam inundation. All other properties are disproportionately exposed to liquefaction (both liquefaction hazards), both landslide hazards, and dam failure, but especially flooding and wildfire threat.

TABLE 5 – Percentage of Estimated Number of Private Buildings in High Hazard Areas* by Type

This table should be read as "Across the region, this percentage of the buildings in this high hazard area is this type of development."

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone
Total Value	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Residential	93.2%	95.0%	93.0%	91.8%	91.3%	96.0%
Commercial	3.8%	2.7%	4.2%	4.9%	4.7%	0.9%
Industrial	3.0%	2.3%	2.8%	3.3%	4.0%	3.1%
	All Land	**100-Year FEMA Flood Zone**	**Rainfall-Induced Landslides**	**Wildfire Threat Area**	**WUI Threat Area**	**Dam Failure Inundation Area**
Total Value	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Residential	93.2%	84.7%	92.6%	87.7%	94.9%	92.0%
Commercial	3.8%	6.9%	1.1%	1.4%	2.9%	4.4%
Industrial	3.0%	8.4%	6.3%	10.9%	2.2%	3.6%

*See Local Hazard Mitigation Plan Appendix E, Information Sources and Definitions for definitions of high hazard areas and data limitations.
Source: ABAG 2006.

Table 6 shows the percentage of buildings in each county that is exposed to the high hazard areas. The highest building exposure is in the high hazard areas for shaking potential, WUI threat, and liquefaction.

TABLE 6 - Percentage of Estimated Number of Buildings in Each High Hazard Area* by County

This table should be read as "In this county, this percentage of all buildings of this type is in this high hazard area"

	All Land	Fault Study Zone	Shaking Potential	Liquefaction Susceptibility	Liquefaction Study Zone	Earthquake-Induced Landslide Study Zone	100-Year FEMA Flood Zone	Rainfall-Induced Landslides	Wildfire Threat Area	WUI Threat Area	Dam Failure Inundation Area
9-County Region											
Total Value	100.0%	1.7%	66.4%	48.0%	17.8%	1.3%	4.4%	2.9%	4.6%	50.8%	19.2%
Residential	100.0%	1.7%	66.3%	47.3%	17.4%	1.4%	4.0%	2.9%	4.3%	51.7%	19.0%
Commercial	100.0%	1.2%	73.0%	61.3%	22.0%	0.3%	7.9%	0.9%	1.7%	38.4%	22.3%
Industrial	100.0%	1.3%	61.5%	52.8%	23.7%	1.4%	12.2%	6.2%	16.4%	37.1%	22.6%
Alameda County											
Total Value	100.0%	3.2%	90.3%	54.2%	42.5%	4.2%	2.5%	1.7%	3.0%	46.1%	33.0%
Residential	100.0%	3.3%	90.1%	53.5%	41.7%	4.4%	2.6%	1.7%	3.0%	46.8%	33.2%
Commercial	100.0%	3.0%	95.7%	63.6%	47.0%	1.0%	1.9%	0.2%	0.7%	36.4%	27.4%
Industrial	100.0%	2.7%	89.8%	62.0%	58.6%	2.1%	2.0%	2.8%	6.5%	36.5%	32.2%
Contra Costa County											
Total Value	100.0%	2.3%	49.2%	34.6%	N/A	N/A	3.5%	5.8%	7.1%	70.2%	12.4%
Residential	100.0%	2.3%	48.9%	33.8%	N/A	N/A	3.1%	5.8%	7.0%	71.1%	11.9%
Commercial	100.0%	2.0%	63.3%	51.4%	N/A	N/A	9.7%	1.9%	2.7%	56.5%	24.8%
Industrial	100.0%	1.7%	39.4%	56.2%	N/A	N/A	15.5%	9.2%	23.5%	35.5%	26.6%
Marin County											
Total Value	100.0%	0.5%	38.4%	41.8%	N/A	N/A	12.0%	12.3%	13.4%	83.5%	6.3%
Residential	100.0%	0.5%	37.0%	39.4%	N/A	N/A	9.6%	13.1%	13.9%	85.2%	6.0%
Commercial	100.0%	0.9%	58.0%	70.3%	N/A	N/A	25.4%	3.0%	6.3%	78.7%	12.4%
Industrial	100.0%	0.7%	42.7%	53.7%	N/A	N/A	33.6%	7.3%	10.4%	64.9%	5.6%
Napa County											
Total Value	100.0%	0.9%	0.4%	22.2%	N/A	N/A	7.4%	2.6%	14.1%	60.6%	20.7%
Residential	100.0%	1.0%	0.1%	21.1%	N/A	N/A	5.9%	1.6%	10.2%	65.1%	20.1%
Commercial	100.0%	1.1%	0.2%	41.8%	N/A	N/A	18.3%	0.7%	3.6%	58.2%	40.5%
Industrial	100.0%	0.5%	2.5%	23.0%	N/A	N/A	13.7%	9.9%	44.7%	30.5%	18.1%
San Francisco County											
Total Value	100.0%	0.0%	80.9%	44.3%	8.0%	1.3%	0.0%	0.3%	0.1%	47.0%	9.8%
Residential	100.0%	0.0%	80.7%	42.6%	6.2%	1.4%	0.0%	0.4%	0.1%	48.8%	10.3%
Commercial	100.0%	0.0%	82.6%	64.3%	26.9%	0.3%	0.0%	0.1%	0.0%	23.3%	2.9%
Industrial	100.0%	0.0%	86.8%	81.3%	50.7%	0.0%	0.0%	0.0%	0.0%	12.8%	1.2%
San Mateo County											
Total Value	100.0%	2.1%	92.3%	37.2%	N/A	N/A	4.4%	2.7%	2.0%	56.4%	15.1%
Residential	100.0%	2.2%	92.3%	36.2%	N/A	N/A	4.0%	2.8%	1.9%	57.6%	14.7%
Commercial	100.0%	0.6%	95.6%	44.4%	N/A	N/A	8.5%	0.8%	0.7%	44.6%	14.6%
Industrial	100.0%	0.5%	88.3%	57.3%	N/A	N/A	11.1%	3.6%	5.0%	35.0%	26.1%
Santa Clara County											
Total Value	100.0%	0.8%	72.9%	67.4%	38.3%	1.6%	6.8%	0.9%	1.9%	34.2%	29.6%
Residential	100.0%	0.8%	72.4%	67.2%	37.8%	1.6%	6.3%	0.7%	1.6%	34.6%	28.9%
Commercial	100.0%	0.1%	79.5%	74.7%	41.8%	0.3%	10.1%	0.3%	0.6%	24.6%	38.6%
Industrial	100.0%	1.7%	81.7%	64.9%	51.0%	5.5%	18.6%	6.7%	17.8%	31.7%	44.9%
Solano County											
Total Value	100.0%	0.5%	3.8%	37.2%	N/A	N/A	5.5%	1.0%	1.5%	36.1%	9.5%
Residential	100.0%	0.5%	3.5%	36.4%	N/A	N/A	5.0%	1.0%	1.5%	36.4%	9.1%
Commercial	100.0%	0.1%	7.1%	56.3%	N/A	N/A	11.8%	1.2%	1.4%	26.4%	18.4%
Industrial	100.0%	0.4%	9.9%	33.3%	N/A	N/A	13.2%	0.7%	2.8%	41.7%	8.9%
Sonoma County											
Total Value	100.0%	1.5%	53.4%	45.1%	N/A	N/A	2.7%	4.8%	12.7%	52.6%	0.0%
Residential	100.0%	1.5%	53.7%	45.4%	N/A	N/A	2.6%	4.5%	11.9%	53.7%	0.0%
Commercial	100.0%	1.6%	56.9%	56.1%	N/A	N/A	5.4%	1.5%	5.8%	43.1%	0.0%
Industrial	100.0%	0.8%	41.9%	30.1%	N/A	N/A	4.4%	13.8%	37.4%	36.4%	0.0%

*See Local Hazard Mitigation Plan Appendix E, Information Sources and Definitions for definitions of high hazard areas and data limitations.

Source: ABAG 2006.

Almost two thirds of the buildings (66.4% or 1.18 million properties) in the region are in the high hazard area for shaking, while 50.8% (906,355 buildings) are in a WUI threat area, and 48.0% (856,893 buildings) is in a high liquefaction susceptibility area. As with estimated value, these are again the same three high hazard areas that contain the highest acreages of urban land in the region (see LHMP Appendix E, Figure 2). Of the other hazards, only dam inundation areas contain a significant portion of the value in the region (19.2%). These results are highly consistent with the exposed values in hazard areas, with the percentages of buildings in the high hazard areas within a few percentage points of the percentage of exposed value.

No estimate of the *total* number of public and institutional buildings exists for the Bay Area. Exposure of many public and institutional critical facilities to hazards is described in Appendix C.

Definitions, Methodologies, and Information Sources

Definitions

For definitions of high hazard areas, see "Information Sources, Definitions, and Hazard Analysis Limitations" in Appendix E.

The analysis in this section is based on three basic breakdowns of privately-owned property. *Other properties, such as schools, hospitals, municipal buildings, and institutional properties, are analyzed as critical facilities in Appendix C. While a limited number of local governments provided ABAG staff with the insured values of these structures, the data are insufficient to make a consistent estimate of the value of these structures.* The three categories of property analyzed are:

- **Residential and Mixed-Use** – including homes, condominiums, apartments, and mixed-use buildings with commercial on the ground floor.
- **Commercial and Recreational** – including retail, office, recreational, motels/hotels, research and development, and properties with mixed commercial and light industrial buildings.
- **Industrial and Other** – including light and heavy industrial, recycling, warehousing, communications, food processing, and other non-commercial and non-residential uses.

The categories of land use for the properties were obtained from the 2005 Existing Land Use Map (Perkins and others, 2005) and assessor's land use information for the parcel.

Exposure Estimates Methodology and Information Sources

Creating the Parcel Layers

Estimates of market value of private buildings were based upon County Tax Assessors' information, collected on a parcel level for every parcel in the region. For the majority of counties, this information came with parcel maps for the county, allowing for the use of Geographic Information Systems (GIS) technology to assign spatial qualities to the attributes. There were three counties, however, in which GIS parcel layers (data tables with spatial information) were unavailable for the complete county. The exposure estimates are summarized by land use type based upon the 2005 Existing Land Use Map (see LHMP Appendix E), which was used to assign standardized land uses to each of the parcels. Parcel data tables (with no spatial information) were available for all nine counties in the region.

For the three counties without assessors' parcel layers, different methods were used to assemble the parcel layers.

- In Santa Clara County, a complete GIS parcel layer was created with parcel layers obtained from a number of cities in the county (San Jose, Milpitas, Santa Clara, Palo Alto, and Cupertino). In areas where there were still no parcels, a 2003 GIS parcel layer was obtained from the Santa Clara Valley Transit Authority and was used to fill in missing areas in the GIS parcel layer.
- In Alameda County, GIS parcel layers were collected for every city except the cities of Alameda and Albany. There were no other parcel layers available for the county, and so the parcel layer remained incomplete for Alameda County (approximately 93% complete).
- In Solano County, GIS parcel layers were collected from the three largest cities in the county (Vacaville, Fairfield, and Vallejo). There were no other parcel layers available for the county, and so the parcel layer remained incomplete for Solano County (approximately 50% complete). The available parcel layers, however, do capture roughly two-thirds of the urban area (and thus most of the improvement value) in that county.

Since the resulting parcel layer was incomplete for Alameda and Solano Counties, two additional steps were taken to increase the accuracy of the following estimates for these two counties.

1. Parcel records were geocoded (assigned spatial data based upon addresses) to create a point layer for all parcels that were not included in the available parcel layers for the county.
2. These geocoded points were added to the point parcel layer for that county to create a more accurate estimate of the number and value of the buildings in the hazard areas.

This does not mean that the combined tables are a complete list of all parcels in these counties for two reasons. First, geocoding is often inaccurate with some of the parcels due to bad address or zip code information. In addition, many parcels cannot be geocoded because there are no addresses for the parcel or the reference street layer does not have a street present on it.

- In Alameda County, all parcels in the cities of Alameda and Albany were geocoded to create a point layer for these cities. Using this method, 84% of the parcel records in Alameda and Albany were successfully included.
- In Solano County, a similar procedure was used. However, in this county, only 57% of the parcel records outside of the cities of Vacaville, Fairfield, and Vallejo were successfully included.

Thus, for both of these counties, not all parcels were assigned spatial data, resulting in the estimates of the number of buildings and value of improvements being low when compared to the actual number of buildings and value of improvements. This underestimate is more severe in Solano County than Alameda County). In effect, the geocoding effort lessened, but did not remove, the underestimation of parcels and value.

In order to determine whether a parcel was in a hazard area, the point at the geographical center ("centroid") of the parcel was determined in GIS and "joined" (spatially linked) to the hazard area layers used in this LHMP. When geocoding was required, the point used for "joining" with the hazard layer is the location of the address, which is in the center of the street in front of the parcel.

Total Number of Buildings Exposed

While the number of buildings is occasionally included in assessor's parcel information, this information is very incomplete and may also be inaccurate, as identifying the number of buildings is

not the focus of the assessor's work. Instead, for all parcels where a positive assessed improvement value indicated that a building was present on the parcel, it was assumed that there was one building per parcel. While this assumption is accurate for most single family homes (which comprise the majority of Bay Area development), it is also introduces several sources of error. First, all apartment, condominium, office, and industrial complexes that are considered to be one parcel by the assessor may actually be composed of several buildings. In addition, many single-family parcels consist of in-law units or detached garages, which are also separate buildings. Finally, many condominiums, although they are in one building, are considered to be separate parcels. The first two inaccuracies suggest that the assumption of one building per parcel will underestimate the number of buildings exposed to a hazard, and the last suggests that the assumption will overestimate the number of buildings exposed to a hazard. Overall, the first two inaccuracies are much more common, meaning that the number of buildings exposed to a hazard is likely to be higher than the statistics presented here.

To determine the number of parcels (and estimated buildings) in a hazard area, the centroid for each parcel was joined to the hazard layer. Parcels were counted for each hazard category for each county.

Total Value of Improvements Exposed

Exposure estimates were created using the assessed value of improvements for every parcel. In California, however, the assessed value of a property is rarely equal to the real market value of the property. Proposition 13, passed in 1978, limits the amount of value that the assessor can claim real property to be worth. Specifically, after a property is sold, the assessor can only raise the assessed value of the property at a maximum of 2% per year, even if the market inflates the value significantly more than 2%. Once the property is sold again, the assessor can use that sales price as the new assessed value. Thus the assessed value is equal to the real market value only in the year when the property is sold. The longer it has been since the property was sold, the larger discrepancy that will exist between the assessed value and the real market value of the property (with the assessed value generally much lower than the market value). While this is a significant problem for all properties, it is likely an even larger problem for nonresidential properties, which have very low turnover when compared with residential properties.

ABAG's estimates adjusted for the above situation by estimating the real market value based upon the assessed value of the property, the last sales price, and the last sales date, as well as the land use for the property (as obtained from the 2005 Existing Land Use Map and assessor's land use information for the parcel). The assessed values were obtained directly from the County Assessor for four counties – Contra Costa, Marin, San Francisco, and San Mateo. For the remaining five counties, the data were purchased from First American Real Estate Solutions (Metroscan). Sales information was not always available, and the adjustment process accounted for this fact.

<u>Estimating the Real Value</u>

1. If a property had no sales information or was sold before 1976 (the effective date of Proposition 13), the assessed value of improvements was assumed to be the correct market value in 1976. This assumption was made because properties with no sales information were likely sold before the quality of information was at current standards (and thus before 1976). This assumption may have had the effect of over-inflating values for properties with no sales

date information if they were sold after 1976. The assessed value was inflated by an index based upon its land use category (see below) to 2005 current market value.

2. If a property had all sales information and was sold after 1976, the sales price was adjusted by the ratio of improvements to land value to obtain the market value of the improvements for the year of the sale. This value was then inflated by an index based upon the parcel land use category (see below) to 2005 current market value. If there was no ratio of improvements for the parcel, the median ratio of improvements to land value for the land use category in that county was used to estimate the improvement value for the year of the sale (which was then inflated by the index).

Inflation Indices

The first land use category included all residential properties: single-family homes, multi-family homes, apartment buildings, mixed-use (residential/commercial) buildings, mobile parks, and group quarters. The index for residential properties was created using the average single-family home sales price from 1989-2005 by county, and a single-family home market trend index for 1976-1989 by subregion (1-4 counties). These data were provided by the Real Estate Research Council of Northern California in the Northern California Real Estate Reports (1990, 1996, 2005).

The second category was for all other properties, including commercial, industrial, and any other type of property that had an improvement value for the parcel. This index was created from the Consumer Price Index (CPI) for the entire region. This index generally inflated the assessed value at a considerably smaller rate than the single-family home index, reflecting the rapidly inflating housing market in the Bay Area.

Trial estimates included a separate index for multi-family housing, using the rental CPI for the entire Bay Area from 1982-2005, and the Housing CPI for 1976-1982. This index was later not used largely because, in the Bay Area, the rental market is not as profitable as the real estate investment market. This trend means that the rental CPI for the region was likely to underestimate the value of the properties. Thus, investors in rental housing are treating this investment as a housing investment with expectations of future gains in line with the overall regional real estate market, rather than as income properties with a market value based on rental income. A single-family market index was more reflective of that fact.

Almost all of the assumptions made in this analysis underestimated the value of buildings in the Bay Area. The CPI inflator for non-residential properties is also probably low because real estate has traditionally gone up in value faster than the other commodities in that index. It is likely that the actual market value of private improvements in the region is much higher.

Applications and Limitations of the Estimates of Market Value and Comparisons to Other Loss Exposure Estimates

The above numbers are only an estimate of the 2005 market value of private improvements. ABAG created these values only to provide estimates of property at risk in hazard areas. They do not represent scenarios of loss due to hazards, nor do they represent the replacement value (cost of repairing or replacing a structure) that would be damaged or destroyed during a hazard event. In

addition, they do not represent public and other nontaxable improvements, as assessors do not assess the value of these properties.

At least three studies have estimated the value of improvements in the Bay Area in order to develop loss estimates for hazard events: (1) FEMA's HAZUS model, (2) independent work by Risk Management Solutions (RMS), (3) Kircher and others (2006) in the estimate of losses due to a repeat of the 1906 earthquake. The first two estimates calculate the engineered replacement value based on an estimated square footage of building stock (based on census data of population) multiplied by an average cost per square foot for various types of construction (from Means). Kircher and others modified the HAZUS values based on an "average" ratio between the RMS and HAZUS default values. ***Table 7*** compares these replacement values from HAZUS, Kircher and others, and RMS, with the market value estimates used in this analysis. The values in this appendix are generally significantly higher than the other estimates.

When losses occur, replacement value is a better estimator of actual losses than fair market value. If these market values were converted to replacement values, they would increase for at least two reasons. First, replacement value assumes replacing structures, which typically costs more than the fair market value of the old structure. Second, even in a localized emergency, there are market factors that increase the price of materials and labor further as they are in short supply relative to the demand. Kircher and others estimated that, in a 1906 event, this would inflate losses by approximately 30%. Thus, to convert the numbers in this appendix for use in loss estimates would require that two multipliers be used – the first to convert market value to replacement value in a non-disaster climate, and a second to convert non-disaster replacement value to disaster replacement value. These two multipliers could easily increase the loss exposures by 50%.

Loss Estimates – The Next Step

One of the most useful ways to examine Bay Area risk is to estimate the total losses that might be expected from a variety of hazards over a given period, such as 100 years, or to change those losses to an average annual exposure. The principal use for such estimates by a local government in the Bay Area is likely to be to determine the costs of ***not*** mitigating a hazard to compare against the costs and benefits of hazard mitigation.

To obtain these loss estimates, one needs the probability of the event occurring. For example, in a 100-year, one could assume that one flood would completely inundate the 100-year floodplain or that the wildfires of the last 50 years would occur twice. During the same interval, various earthquake scenarios would have a fixed probability of occurring.

One also needs the probability of the event resulting in damage to a particular location. In this case, those hazards that have various levels of severity (such as wildfire threat, earthquake shaking and liquefaction) will have various probabilities of damage based on whether the hazard is very high, high, or moderate.

TABLE 7 – Comparison of ABAG Market Value of Private Improvements to Other Sources of Replacement Value for Use in Loss Estimates (Millions of Dollars)

Residential Properties	Assessed Improvement Value	HAZUS	Kircher and others	RMS	ABAG Estimated Market Value
Alameda	62,038	100,936	111,030	112,203	153,329
Contra Costa	49,243	74,902	82,392	74,759	124,098
Marin	17,425	24,338	26,772	25,961	39,450
Napa	5,568	9,126	10,039	10,166	14,502
San Francisco	21,446	56,633	62,296	72,001	71,802
San Mateo	40,728	57,814	63,595	64,316	116,238
Santa Clara	71,099	123,200	135,520	153,773	193,968
Solano	12,680	25,519	28,071	23,606	47,601
Sonoma	22,129	35,203	38,723	31,243	76,472
Total	302,356	507,671	558,438	568,028	837,459

Employment Properties	Assessed Improvement Value	HAZUS	Kircher and others	RMS	ABAG Estimated Market Value
Alameda	19,843	26,169	52,338	45,735	34,443
Contra Costa	19,357	10,207	20,414	19,687	47,771
Marin	3,197	4,639	9,278	8,217	8,588
Napa	1,105	2,270	4,540	3,641	6,879
San Francisco	20,898	18,941	37,882	40,334	26,392
San Mateo	10,665	10,353	20,706	21,410	29,699
Santa Clara	27,073	23,896	47,792	54,865	53,167
Solano	1,904	3,375	6,750	5,793	6,563
Sonoma	4,660	6,067	12,134	9,426	13,080
Total	108,702	105,917	211,834	209,108	226,584

All Properties	Assessed Improvement Value	HAZUS	Kircher and others	RMS	ABAG Estimated Market Value
Alameda	85,398	123,271	155,700	157,938	187,772
Contra Costa	73,607	85,109	102,807	94,446	171,869
Marin	22,211	28,977	36,050	34,178	48,038
Napa	10,077	11,396	14,579	13,807	21,381
San Francisco	44,290	75,574	100,179	112,335	98,194
San Mateo	53,679	68,167	84,301	85,726	145,937
Santa Clara	104,329	147,096	183,312	208,638	247,135
Solano	16,124	28,894	34,820	29,399	54,164
Sonoma	28,675	41,270	50,858	40,669	89,552
Total	438,390	609,754	762,606	777,136	1,064,043

Finally, one needs an estimate of the damage to property that might occur should an event happen. For example, if an area is burned in a wildfire, it is reasonable to assume that the entire building and its contents are 100% destroyed. On the other hand, if a building is flooded, it is damaged but not destroyed. In the most complex case, if a building is shaking in an earthquake, it may be undamaged or completely destroyed or anything in between based on the type and quality of building construction.

Published loss estimates are becoming increasingly sophisticated as the information on probability and damage becomes increasingly well understood based on statistics and other information from past disasters. However, the estimates are typically published for the State, a region, or a county, not for a particular city or neighborhood. The reason for the reluctance of modelers to publish more generic loss estimates is that the data become increasingly unreliable at more local levels. The data on building numbers and values included in this report should greatly improve future estimates.

ABAG could use existing software and modeling to produce loss estimates for the various hazards in the region. Even the data produced for this appendix would improve existing loss estimates. For example, the losses estimated by Kircher and others might be assumed to be low by approximately one-third based on the information in ***Table 7***, above. However, other information, such as the precise location and number of soft-story multifamily residential buildings and retrofitted and unretrofitted unreinforced masonry buildings is equally important.

The recommendation of this appendix is that future Bay Area loss estimates be conducted on a parcel-by-parcel basis and aggregated to census tracts and cities. To accomplish this goal, ABAG will seek funding to collect and improve building inventory information and use it to prepare loss estimates for use by cities, counties, and special districts for benefit-cost-analysis of hazard mitigation programs. The focus of these efforts will be on buildings that are statistically more vulnerable in earthquakes (both unretrofitted and retrofitted to a minimal standard): unreinforced masonry buildings, soft-story multifamily residential buildings, tilt-up concrete buildings, and non-ductile concrete frame buildings.

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